



The Use and Misuse of Fruit Juice in Pediatrics (RE0047)

AMERICAN ACADEMY OF PEDIATRICS

Committee on Nutrition

ABSTRACT. Historically, fruit juice was recommended by pediatricians as a source of vitamin C and an extra source of water for healthy infants and young children as their diets expanded to include solid foods with higher renal solute. Fruit juice is marketed as a healthy, natural source of vitamins and, in some instances, calcium. Because juice tastes good, children readily accept it. Although juice consumption has some benefits, it also has potential detrimental effects. Pediatricians need to be knowledgeable about juice to inform parents and patients on its appropriate uses.

ABBREVIATIONS. FDA, Food and Drug Administration; AAP, American Academy of Pediatrics.

INTRODUCTION

In 1997, US consumers spent almost \$5 billion on refrigerated and bottled juice.¹ Mean juice consumption in America is more than 2 billion gal/y or 9.2 gal/y per person.² Children are the single largest group of juice consumers. Children younger than 12 years account for only about 18% of the total population but consume 28% of all juice and juice drinks.³ By 1 year of age, almost 90% of infants consume juice. The mean daily juice consumption by infants is approximately 2 oz/d, but 2% consume more than 16 oz/d, and 1% of infants consume more than 21 oz/d.^{2,4,5} Toddlers consume a mean of approximately 6 oz/d.² Ten percent of children 2 to 3 years old and 8% of children 4 to 5 years old drink on average more than 12 oz/d.² Adolescents consume the least, accounting for only 10% of juice consumption.

DEFINITIONS

To be labeled as a fruit juice, the Food and Drug Administration (FDA) mandates that a product be 100% fruit juice. For juices reconstituted from concentrate, the label must state that the product is reconstituted from concentrate. Any beverage that is less than 100% fruit juice must list the percentage of the product that is fruit juice, and the beverage must include a descriptive term, such as "drink," "beverage," or "cocktail." In general, juice drinks contain between 10% and 99% juice and added sweeteners, flavors, and sometimes fortifiers, such as vitamin C or calcium. These ingredients must be listed on the label, according to FDA regulations.

COMPOSITION OF FRUIT JUICE

Water is the predominant component of fruit juice. Carbohydrates, including sucrose, fructose, glucose, and sorbitol, are the next most prevalent nutrient in juice. The carbohydrate concentration varies from 11 g/100 mL (0.44 kcal/mL) to more than 16 g/100 mL (0.64 kcal/mL). Human milk and standard infant formulas have a carbohydrate concentration of 7 g/100 mL.

Juice contains a small amount of protein and minerals. Juices fortified with calcium have approximately the same calcium content as milk but lack other nutrients present in milk. Some juices have high contents of potassium, vitamin A, and vitamin C. In addition, some juices and juice drinks are fortified with vitamin C. The vitamin C and flavonoids in juice may have beneficial long-term health effects, such as decreasing the risk of cancer and heart disease.^{6,7} Drinks that contain ascorbic acid consumed simultaneously with food can increase iron absorption by twofold.^{8,9} This may be important for children who consume diets with low iron bioavailability.

Juice contains no fat or cholesterol, and unless the pulp is included, it contains no fiber. The fluoride concentration of juice and juice drinks varies. One study found fluoride ion concentrations ranged from 0.02 to 2.8 parts per million.¹⁰ The fluoride content of concentrated juice varies with the fluoride content of the water used to reconstitute the juice.

Grapefruit juice contains substances that suppress a cytochrome P-450 enzyme in the small bowel wall. This results in altered absorption of some drugs, such as cisapride, calcium antagonists, and cyclosporin.¹¹⁻¹³ Grapefruit juice should not be consumed when these drugs are used.

Some manufacturers specifically produce juice for infants. These juices do not contain sulfites or added sugars and are more expensive than regular fruit juice.

ABSORPTION OF CARBOHYDRATE FROM JUICE

The 4 major sugars in juice are sucrose, glucose, fructose, and sorbitol. Sucrose is a disaccharide that is hydrolyzed into 2 component monosaccharides, glucose and fructose, by sucrase present in the small bowel epithelium. Glucose is then absorbed rapidly via an active-carrier-mediated process in the brush border of the small bowel. Fructose is absorbed by a facilitated transport mechanism via a carrier but not against a concentration gradient. In addition, fructose may be absorbed by a disaccharidase-related transport system, because the absorption of fructose is more efficient in the presence of glucose, with maximal absorption occurring when fructose and glucose are present in equimolar concentrations.¹⁴ Clinical studies have demonstrated this, with more apparent malabsorption when fructose concentration exceeds that of glucose (eg, apple and pear juice) than when the 2 sugars are present in equal concentrations (eg, white grape juice).^{15,16} However, when provided in appropriate amounts (10 mL/kg of body weight), these different juices are absorbed equally as well.¹⁷ Sorbitol is absorbed via passive diffusion at slow rates, resulting in much of the ingested sorbitol being unabsorbed.¹⁸

Carbohydrate that is not absorbed in the small intestine is fermented by bacteria in the colon. This bacterial fermentation results in the production of hydrogen, carbon dioxide, methane, and the short-chain fatty acids—acetic, propionic, and butyric. Some of these gases and fatty acids are reabsorbed through the colonic epithelium, and in this way, a portion of the malabsorbed carbohydrate can be scavenged.¹⁹ Nonabsorbed carbohydrate presents an osmotic load to the gastrointestinal tract, which causes diarrhea.²⁰

Malabsorption of carbohydrate in juice, especially when consumed in excessive amounts, can result in chronic diarrhea, flatulence, bloating, and abdominal pain.²¹⁻²⁷ Fructose and sorbitol have been implicated most commonly,^{15,16,28-30} but the ratios of specific carbohydrates may also be important.³¹ The malabsorption of carbohydrate that can result from large intakes of juice is the basis for some health care providers to recommend juice for the treatment of constipation.³²

JUICE IN THE FOOD GUIDE PYRAMID

Fruit is 1 of the 5 major food groups in the Food Guide Pyramid.³³ It is recommended that children consuming approximately 1600 kcal/d (depending on size, 1-4 years old) should have 2 fruit servings and those consuming 2800 kcal/d (depending on size, 10-18 years old) should consume 4 fruit servings. Half of these servings can be provided in the form of fruit juice (not fruit drinks). A 6-oz glass of fruit juice equals 1 fruit serving. Fruit juice offers no nutritional advantage over whole fruit. In fact, fruit juice lacks the fiber of whole fruit. Kilocalorie for kilocalorie, fruit juice can be consumed more quickly than whole fruit. Reliance on fruit juice instead of whole fruit to provide the recommended daily intake of fruits does not promote eating behaviors associated with consumption of whole fruits.

MICROBIAL SAFETY OF JUICE

Only pasteurized juice is safe for infants, children, and adolescents. Pasteurized fruit juices are free of microorganisms. Unpasteurized juice may contain pathogens, such as *Escherichia coli* and *Salmonella* and *Cryptosporidium* organisms.³⁴ These organisms can cause serious disease, such as hemolytic-uremic syndrome, and should never be given to infants and children. Unpasteurized juice must contain a warning on the label that the product may contain harmful bacteria.³⁵

INFANTS

The American Academy of Pediatrics (AAP) recommends that breast milk be the only nutrient fed to infants until 4 to 6 months of age.³⁶ For mothers who cannot breastfeed or choose not to breastfeed, a prepared infant formula can be used and is a complete source of nutrition. No additional nutrients are needed. There is no nutritional indication to feed juice to infants

younger than 6 months. Offering juice before solid foods are introduced into the diet could risk having juice replace breast milk or infant formula in the diet. This can result in reduced intake of protein, fat, vitamins, and minerals such as iron, calcium, and zinc.³⁷ Malnutrition and short stature in children have been associated with excessive consumption of juice.^{4,38}

After approximately 4 to 6 months of age, solid foods can be introduced into the diets of infants. The AAP recommends that single-ingredient foods be chosen and introduced 1 at a time at weekly intervals. Iron-fortified infant cereals or pureed meats are good choices for first weaning foods. Because foods high in iron are recommended as weaning foods, beverages that contain vitamin C do not offer a nutritional advantage for iron-sufficient individuals.

It is prudent to give juice only to infants who can drink from a cup (approximately 6 months or older). Teeth begin to erupt at approximately 6 months of age. Dental caries have also been associated with juice consumption.³⁹ Prolonged exposure of the teeth to the sugars in juice is a major contributing factor to dental caries. The AAP and the American Academy of Pedodontics recommendations state that juice should be offered to infants in a cup, not a bottle, and that infants not be put to bed with a bottle in their mouth.⁴⁰ The practice of allowing children to carry a bottle, cup, or box of juice around throughout the day leads to excessive exposure of the teeth to carbohydrate, which promotes development of dental caries.

Fruit juice should be used as part of a meal or snack. It should not be sipped throughout the day or used as a means to pacify an unhappy infant or child. Because infants consume fewer than 1600 kcal/d, 4 to 6 oz of juice per day, representing 1 food serving of fruit, is more than adequate. Infants can be encouraged to consume whole fruits that are mashed or pureed.

The AAP practice guideline on the management of acute gastroenteritis in young children recommends that only oral electrolyte solutions be used to rehydrate infants and young children and that a normal diet be continued throughout an episode of gastroenteritis.⁴¹ Surveys show that many health care providers do not follow the recommended procedures for management of diarrhea.⁴² The high carbohydrate content of juice (11-16 g %), compared with oral electrolyte solutions (2.5-3 g %), may exceed the intestine's ability to absorb carbohydrate, resulting in carbohydrate malabsorption. Carbohydrate malabsorption causes osmotic diarrhea, increasing the severity of the diarrhea already present.⁴³ Fruit juice is low in

electrolytes. The sodium concentration is 1 to 3 mEq/L. Stool sodium concentration in children with acute diarrhea is 20 to 40 mEq/L. Oral electrolyte solutions contain 40 to 45 mEq/L of sodium. As a replacement for fluid losses, juice may predispose infants to development of hyponatremia.

In the past, there was concern that infants who were fed orange juice were likely to develop an allergy to it. The development of a perioral rash in some infants after being fed freshly squeezed citrus juice is most likely a contact dermatitis attributable to peel oils.⁴⁴ Diarrhea and other gastrointestinal symptoms observed in some infants were most likely attributable to carbohydrate malabsorption. Although allergies to fruit may develop early in life, they are uncommon.⁴⁵

TODDLERS AND YOUNG CHILDREN

Most issues relevant to juice intake for infants are also relevant for toddlers and young children. Fruit juice and fruit drinks are easily overconsumed by toddlers and young children because they taste good. In addition, they are conveniently packaged or can be placed in a bottle and carried around during the day. Because juice is viewed as nutritious, limits on consumption are not usually set by parents. Like soda, it can contribute to energy imbalance. High intakes of juice can contribute to diarrhea, overnutrition or undernutrition, and development of dental caries.

OLDER CHILDREN AND ADOLESCENTS

Juice consumption presents fewer nutritional issues for older children and adolescents, because they consume less of these beverages. Nevertheless, it seems prudent to limit juice intake to two 6-oz servings, or half of the recommended fruit servings each day. It is important to encourage consumption of the whole fruit for the benefit of fiber intake and a longer time to consume the same kilocalories.

Excessive juice consumption and the resultant increase in energy intake may contribute to the development of obesity. One study found a link between juice intake in excess of 12 oz/d and obesity.⁴ Other studies, however, found that children who consumed greater amounts of juice were taller and had lower body mass index than those who consumed less juice⁴⁶ or found no

relationship between juice intake and growth parameters.⁴⁷ More research is needed to better define this relationship.

CONCLUSIONS

1. Fruit juice offers no nutritional benefit for infants younger than 6 months.
2. Fruit juice offers no nutritional benefits over whole fruit for infants older than 6 months and children.
3. One hundred percent fruit juice or reconstituted juice can be a healthy part of the diet when consumed as part of a well-balanced diet. Fruit drinks, however, are not nutritionally equivalent to fruit juice.
4. Juice is not appropriate in the treatment of dehydration or management of diarrhea.
5. Excessive juice consumption may be associated with malnutrition (overnutrition and undernutrition).
6. Excessive juice consumption may be associated with diarrhea, flatulence, abdominal distention, and tooth decay.
7. Unpasteurized juice may contain pathogens that can cause serious illnesses.
8. A variety of fruit juices, provided in appropriate amounts for a child's age, are not likely to cause any significant clinical symptoms.
9. Calcium-fortified juices provide a bioavailable source of calcium but lack other nutrients present in breast milk, formula, or cow's milk.

RECOMMENDATIONS

1. Juice should not be introduced into the diet of infants before 6 months of age.
2. Infants should not be given juice from bottles or easily transportable covered cups that allow them to consume juice easily throughout the day. Infants should not be given juice at bedtime.
3. Intake of fruit juice should be limited to 4 to 6 oz/d for children 1 to 6 years old. For children 7 to 18 years old, juice intake should be limited to 8 to 12 oz or 2 servings per day.
4. Children should be encouraged to eat whole fruits to meet their recommended daily fruit intake.
5. Infants, children, and adolescents should not consume unpasteurized juice.
6. In the evaluation of children with malnutrition (overnutrition and undernutrition), the health care provider should determine the amount of juice being consumed.
7. In the evaluation of children with chronic diarrhea, excessive flatulence, abdominal pain, and bloating, the health care provider should determine the amount of juice being consumed.
8. In the evaluation of dental caries, the amount and means of juice consumption should be determined.
9. Pediatricians should routinely discuss the use of fruit juice and fruit drinks and should educate parents about differences between the two.

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